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Shin

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(54) **OPTICAL LENS SYSTEM**

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(22) Filed: **Dec. 3, 2007**

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(51) **Int. Cl.**
G02B 9/34 (2006.01)

(52) **U.S. Cl.** **359/773**; 359/715

(58) **Field of Classification Search** 359/715, 359/773
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,950,246 B2 * 9/2005 Amanai 359/773

FOREIGN PATENT DOCUMENTS

JP	2006-126494	5/2006
KR	2004-60621	7/2004
KR	2006-70814	6/2006

* cited by examiner

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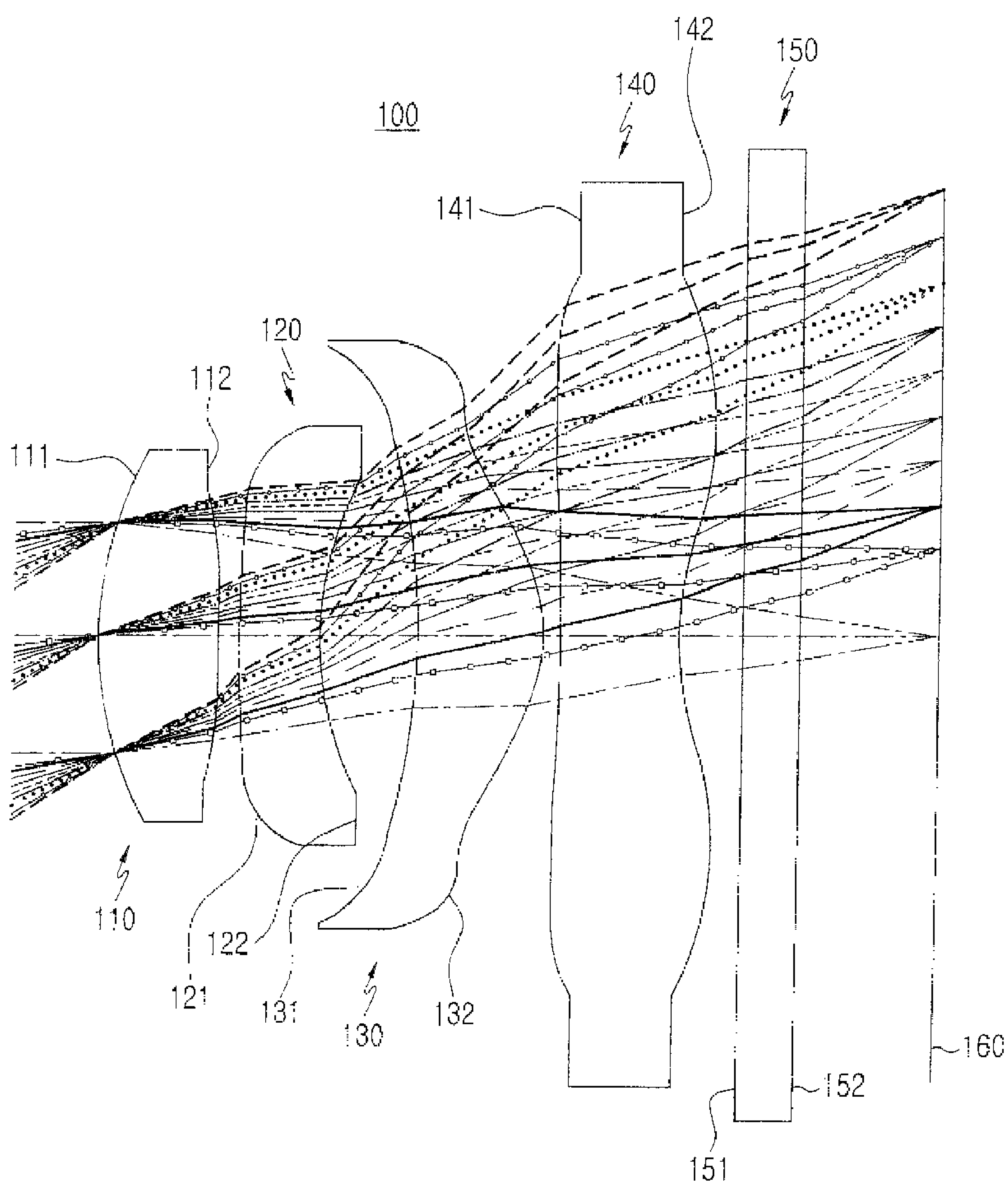
(57) **ABSTRACT**

An optical lens system includes a first lens having positive lens power; a second lens having negative lens power; a third lens having positive lens power; and a fourth lens having negative lens power, wherein the first through fourth lenses are sequentially arranged from a subject.

12 Claims, 6 Drawing Sheets



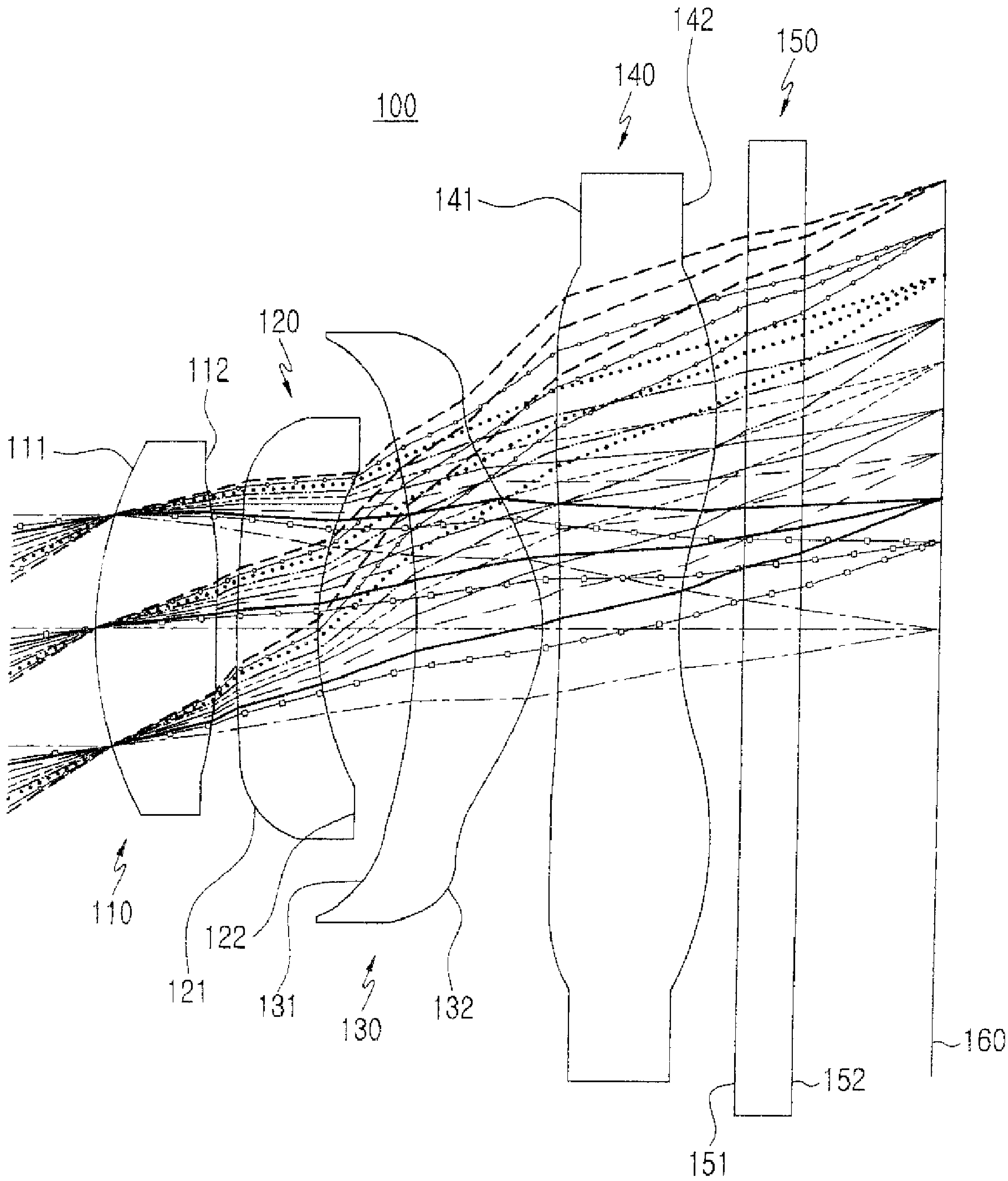

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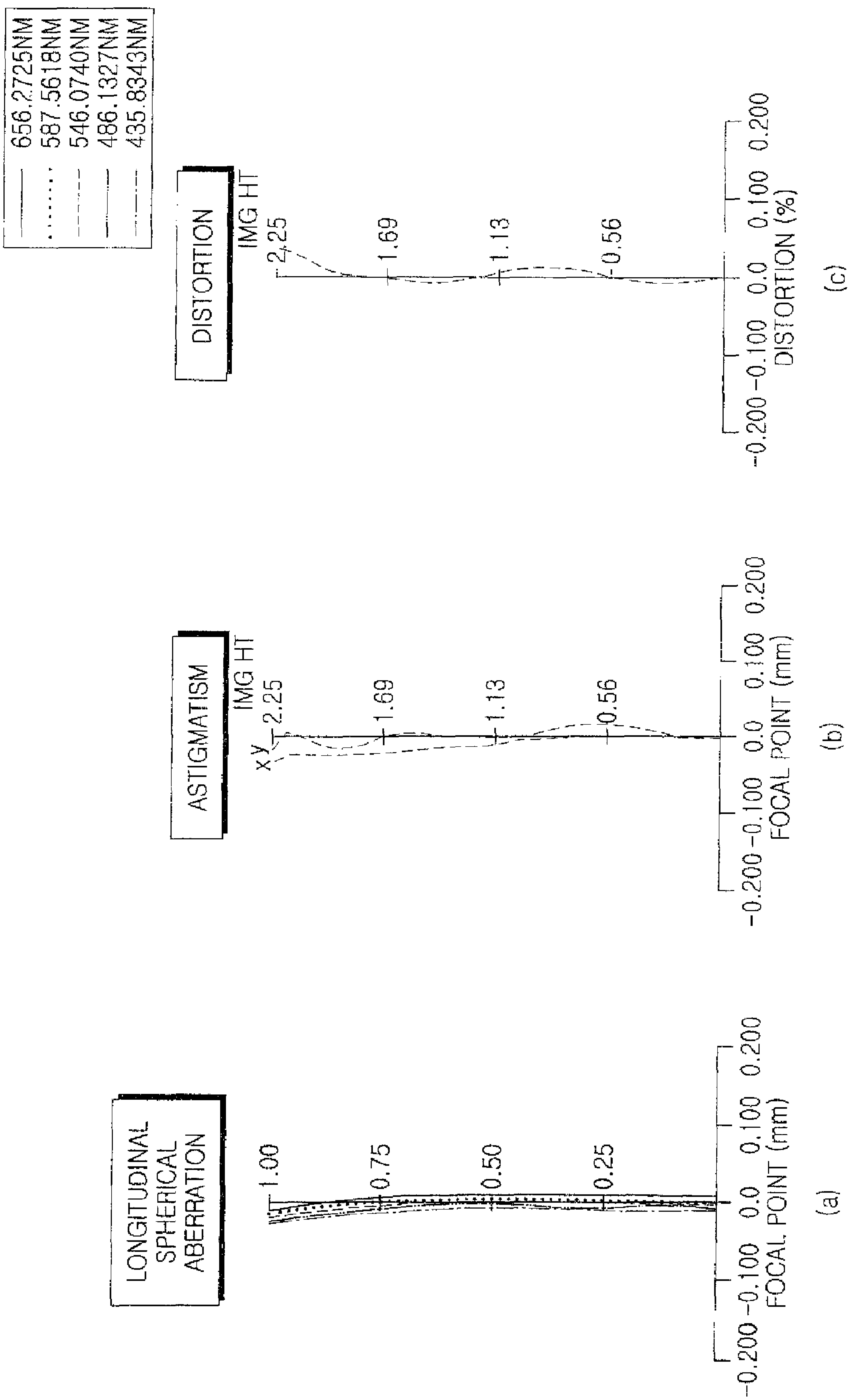
FIG.1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546.0740NM
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1.00
0.75
0.50
0.25
-0.200 -0.100 0.0 0.100 0.200
FOCAL POINT (mm)
(a)
ASTIGMATISM
IMG HT
2.25
1.69
1.13
0.56
X Y
-0.200 -0.100 0.0 0.100 0.200
FOCAL POINT (mm)
(b)
DISTORTION
IMG HT
2.25
1.69
1.13
0.56
-0.200 -0.100 0.0 0.100 0.200
DISTORTION (%)
(c)

FIG. 2

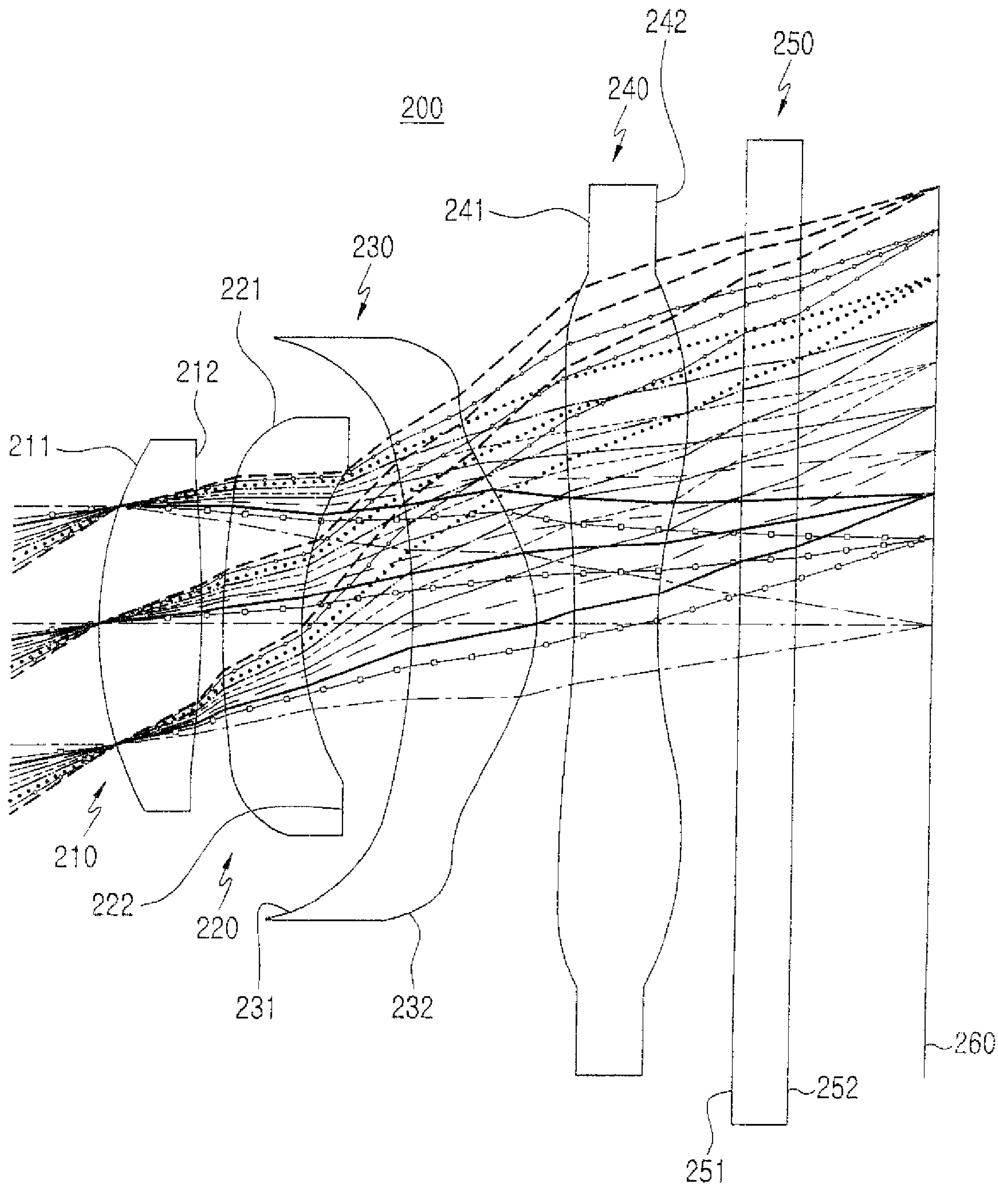
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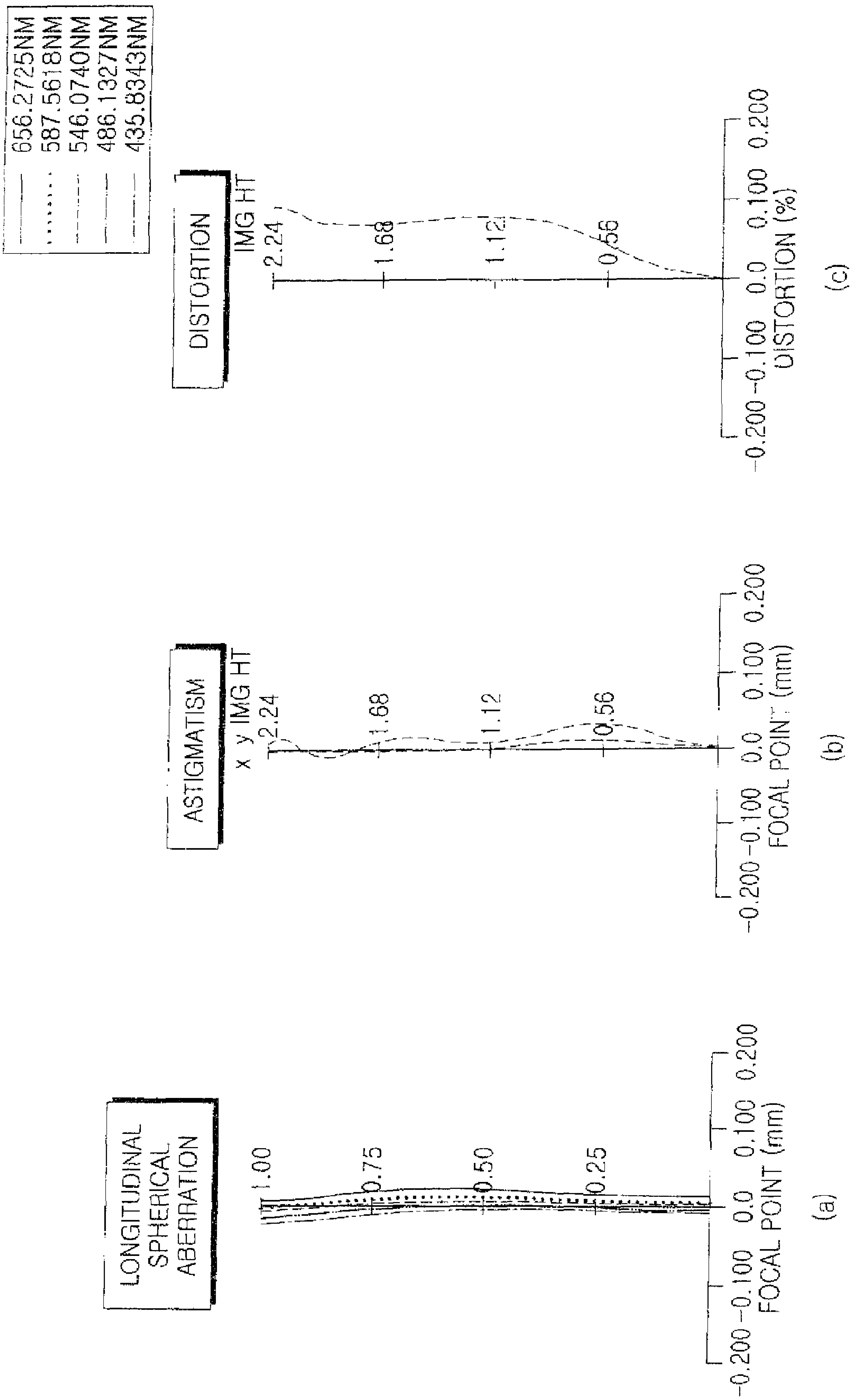
FIG.3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435.8343NM
LONGITUDINAL SPHERICAL ABERRATION
1.00
0.75
0.50
0.25
-0.200 -0.100 0.0 0.100 0.200
FOCAL POINT (mm)
(a)
ASTIGMATISM
x y IMG HT
2.24
1.68
1.12
0.56
-0.200 -0.100 0.0 0.100 0.200
FOCAL POINT (mm)
(b)
DISTORTION
IMG HT
2.24
1.68
1.12
0.56
-0.200 -0.100 0.0 0.100 0.200
DISTORTION (%)
(c)

FIG. 4

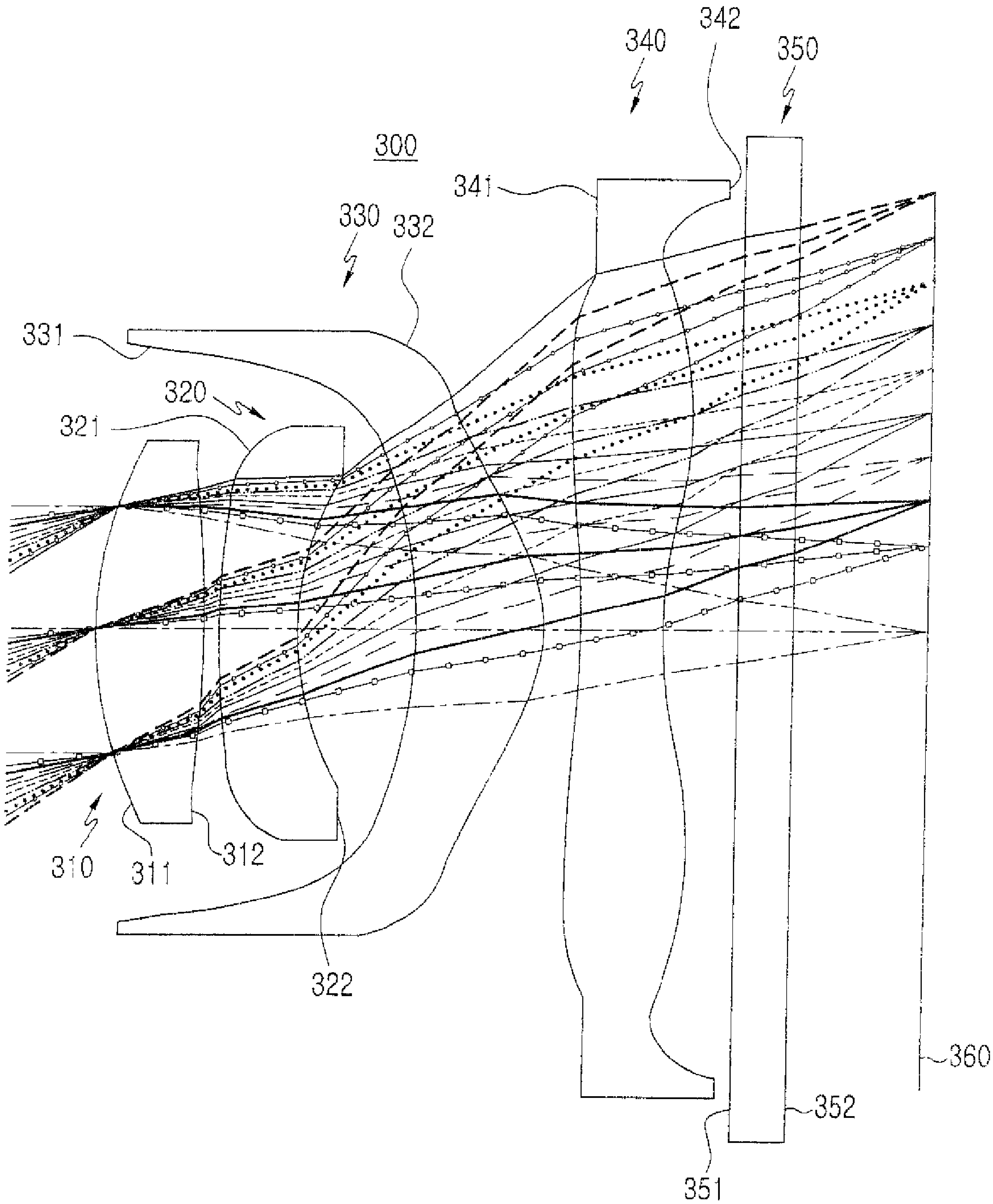
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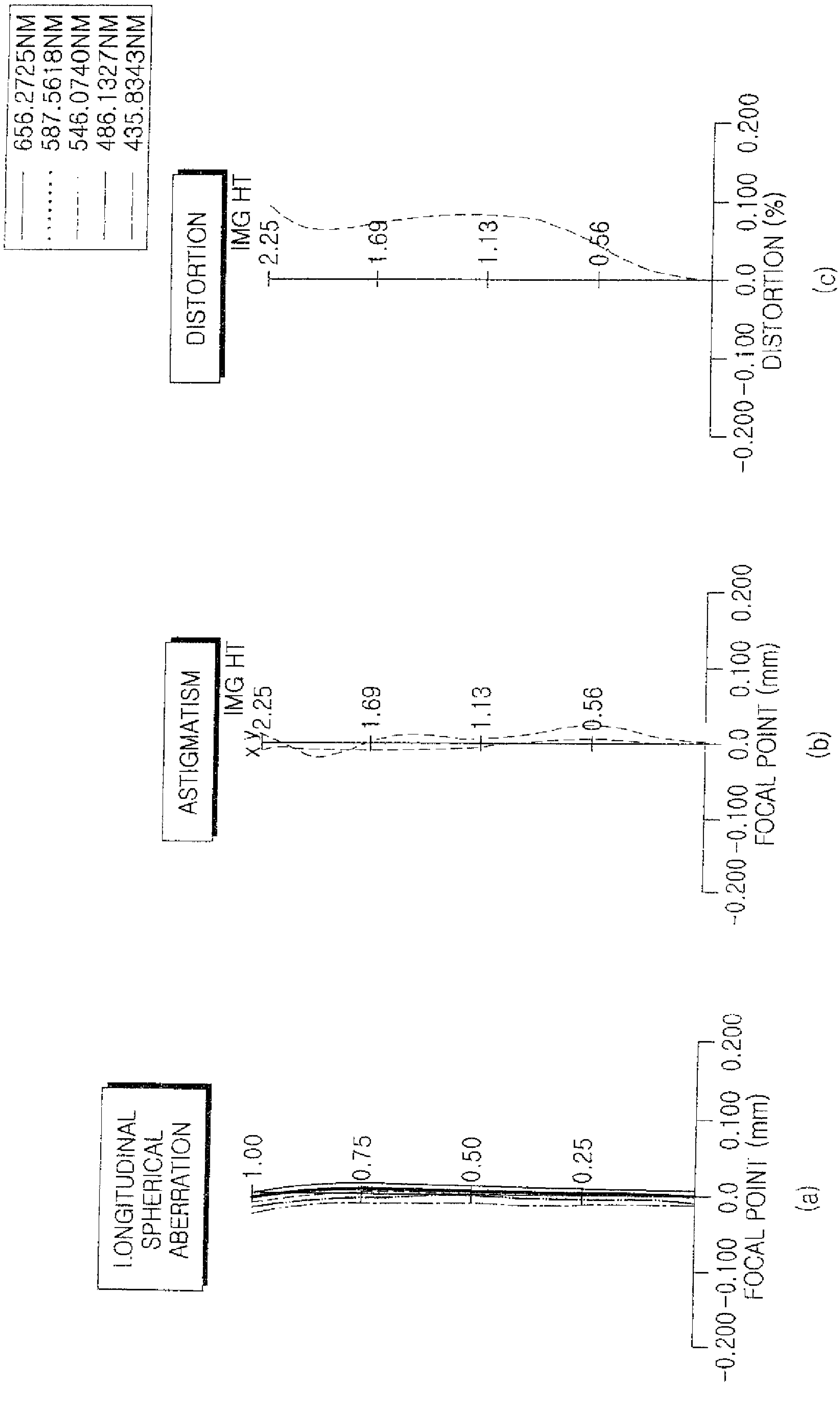
FIG.5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LONGITUDINAL SPHERICAL ABERRATION
1.00
0.75
0.50
0.25
-0.200 -0.100 0.0 0.100 0.200
FOCAL POINT (mm)
(a)
ASTIGMATISM
IMG HT
X Y
2.25
1.69
1.13
0.56
-0.200 -0.100 0.0 0.100 0.200
FOCAL POINT (mm)
(b)
DISTORTION
IMG HT
2.25
1.69
1.13
0.56
-0.200 -0.100 0.0 0.100 0.200
DISTORTION (%)
(c)

FIG.6

OPTICAL LENS SYSTEM

CLAIM OF PRIORITY

This application claims priority to an application entitled "Optical lens system," filed in the Korean Intellectual Property Office on Dec. 4, 2006 and assigned Serial No. 2006-121513, the contents of which are hereby incorporated by reference.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a camera, and more particularly to a camera having a hood.

2. Description of the Related Art

In general, an optical lens system having an image sensor such as a CMOS, a CCD, or the like, is employed in a digital camera. A digital camera is typically used in a surveillance camera, a personal computer, a portable radio communication terminal, etc. The trend in the digital camera including an image sensor is towards miniaturization and high pixel count. Recently, the digital camera has been developed to be mounted to various types of electronic appliances such as a portable digital assistant, a portable radio communication terminal, and so forth.

Therefore, a recently developed digital camera requires a miniaturized optical lens system for a camera. That is to say, as the number of pixels (that is, a pixel density) in an image sensor increases, an optical lens system for a camera having an improved optical characteristic is needed in the art.

However, it is difficult to miniaturize an optical lens system for a camera and apply it to a product having a high pixel count. Also, in the case where lenses equipped with high lens power are positioned adjacent to one another, it is difficult to precisely assemble the lenses.

SUMMARY OF THE INVENTION

Accordingly, the present invention has been made to solve the above-mentioned problems occurring in the prior art and provides additional advantages, by providing an improved optical lens system for a camera which is small and has a high resolution.

In accordance with an aspect of the present invention, there is provided an optical lens system including: a first lens having positive lens power; a second lens having negative lens power; a third lens having positive lens power; and a fourth lens having negative lens power, wherein the first through fourth lenses are sequentially arranged from a subject.

BRIEF DESCRIPTION OF THE DRAWINGS

The above and other aspects, features and advantages of the present invention will be more apparent from the following detailed description taken in conjunction with the accompanying drawings, in which:

FIG. **1** is a view illustrating an optical lens system according to a first embodiment of the present invention;

FIG. **2** is graphs illustrating the aberration characteristics of the optical lens system shown in FIG. **1**;

FIG. **3** is a view illustrating an optical lens system according to a second embodiment of the present invention;

FIG. **4** is graphs illustrating the aberration characteristics of the optical lens system shown in FIG. **3**;

FIG. **5** is a view illustrating an optical lens system according to a third embodiment of the present invention; and

FIG. **6** is graphs illustrating aberration characteristics of the optical lens system shown in FIG. **5**.

DETAILED DESCRIPTION OF THE PRESENT INVENTION

Hereinafter, embodiments of the present invention will be described with reference to the accompanying drawings. For the purposes of clarity and simplicity, a detailed description of known functions and configurations incorporated herein will be omitted as it may make the subject matter of the present invention unclear.

The present invention relates to an optical lens system which can be mounted to a camera, etc. The optical lens system according to the present invention includes a first lens having positive lens power, a second lens having negative lens power, a third lens having positive lens power, and a fourth lens having negative lens power, wherein the first through fourth lenses are sequentially arranged from a subject.

At least one of the first through fourth lenses has an aspherical surface and is made of plastic.

The optical lens system according to the present invention satisfies Mathematical Expressions (1) to (4) below.

$$1 < \frac{f_1}{f_3} < 1.5 \tag{1}$$

In Mathematical Expression (1), f_1 is the effective focal distance of the first lens, and f_3 is the effective focal distance of the third lens. Mathematical Expression (1) represents the relationship between the first lens and the third lens. If the lower limit of 1 is not approached, as the lens power of the first lens increases, spherical aberration and comatic aberration increase. If the upper limit of 1.5 is exceeded, it is difficult to correct chromatic aberration.

$$1.3 < \frac{f_4}{f_2} < 2.0 \tag{2}$$

In Mathematical Expression (2), f_4 is the effective focal distance of the fourth lens, and f_2 is the effective focal distance of the second lens. Mathematical Expression (2) represents the relationship between the fourth lens and the second lens. If the lower limit of 1.3 is not approached, as the lens power of the second lens increases, spherical aberration and comatic aberration increase. If the upper limit of 2.0 is exceeded, it is difficult to correct chromatic aberration.

$$0.4 < \frac{f_3}{f} < 0.7 \tag{3}$$

In Mathematical Expression (3), f_3 is the effective focal distance of the third lens, and f is the effective focal distance of the entire optical lens system. Mathematical Expression (3) represents the lens power of the third lens. If the lower limit of 0.4 is not approached, the spherical aberration of the image obtained through the optical lens system increases. If the upper limit of 0.7 is exceeded, field curvature increases.

$$-1 < \frac{f_4}{f} < -0.4 \quad (4)$$

In Mathematical Expression (4), f_4 is the effective focal distance of the fourth lens, and f is the effective focal distance of the entire optical lens system.

The optical lens system according to the present invention satisfies Mathematical Expression (5) below.

$$20 < \upsilon d_1 - \upsilon d_2 \quad (5)$$

In Mathematical Expression (5), υd_1 is the Abbe's number of the first lens, and υd_2 is the Abbe's number of the second lens. If the lower limit of 20 is not approached, it is difficult to correct chromatic aberration.

An Abbe's number denotes the reciprocal of a dispersion number. In Mathematical Expression (5), d means the wavelength of 587.5618 nm (the helium d-line) which is used in the calculation of an Abbe's number in Mathematical Expression (6) below.

$$\upsilon d = \frac{(Nd - 1)}{(Nf - Nc)} \quad (6)$$

In Mathematical Expression (6), Nd is a refractive index in the case of the helium d-line (wavelength of 587.5618 mm), Nf is a refractive index in the case of the hydrogen f-line (wavelength of 486.1327 nm), and Nc is a refractive index in the case of the hydrogen c-line (wavelength of 656.2725 nm).

In Mathematical Expression (5), the subscripts 1 and 2 are used to differentiate the first and second lenses, and the symbol d can be omitted in the designation of an Abbe's number (hereafter, the symbol d will be omitted in the designation of an Abbe's number).

The optical lens system according to the present invention satisfies Mathematical Expression (7) below.

$$\frac{TTL}{f} < 1.3 \quad (7)$$

In Mathematical Expression (7), TTL is a distance from the first surface of the first lens to an image surface, and/is the effective focal distance of the entire optical lens system. Mathematical Expression (7) represents the overall length of the optical lens system, and 1.3 means the upper limit for miniaturization of the optical lens system.

In the optical lens system, an iris can be arranged between the first lens and the subject, and in some cases, the first surface of the first lens can serve as an iris. Besides, an iris can be arranged between the first lens and the second lens, or the second surface of the first lens can serve as an iris.

FIRST EMBODIMENT

FIG. **1** is a view illustrating an optical lens system according to a first embodiment of the present invention. As shown, the optical lens system **100** according to this first embodiment of the present invention includes first through fourth lenses **110**, **120**, **130** and **140**, an image sensor **160**, and an optical filter **150** arranged between the image sensor **160** and the fourth lens **140**. The first lens **110** has a first surface **111** (S1) and a second surface **112** (S2), the second lens **120** has a third surface **121** (S3) and a fourth surface **122** (S4), and the third lens **130** has a fifth surface **131** (S5) and a sixth surface **132** (S6). Also, the fourth lens **140** has a seventh surface **141** (S7) and an eighth surface **142** (S8). The first surface **111** (S1) of the first lens **110** can serve as an iris, and the position of the iris can be changed as desired by a user when designing the optical lens system **100**.

The optical lens system **100** according to this embodiment of the present invention satisfies the above-described Mathematical Expressions (1) through (7) and the following conditions given in Table 1. In Table 1, f is the focal distance of the entire optical lens system **100**, r is a radius of curvature of a corresponding lens surface, and l is the thickness of a lens or the distance between lenses. In Tables given below, υ designates an Abbe's number (while υ is identical to υd of Mathematical Expression (6), hereinbelow, d will be omitted, and only u will be used to designate an Abbe's number). The mm unit is employed for a length.

The overall effective focal distance of the optical lens system **100** according to the present embodiment is 3.5 mm, f number (f/#) is 2.8, and an angle of view (2ω) is 66.5°.

TABLE 1

	surface condition	R	L	n	υ	remarks
S1	aspherical	1.783	0.621	1.530	55.8	iris
S2	aspherical	−4.288	0.113			
S3	aspherical	8.490	0.411	1.639	23.4	
S4	aspherical	1.775	0.510			
S5	aspherical	−2.319	0.648	1.530	55.8	
S6	aspherical	−0.796	0.090			
S7	aspherical	−42.439	0.620	1.530	55.8	
S8	aspherical	1.162	0.315			
S9		∞	0.3	1.517	64.2	
S10		∞	0.7			

Tables 1 provides data which reveals the basic optical characteristics of the optical lens system **100** according to the present embodiment. That is to say, Table 1 represents the optical characteristics (a radius of curvature, a refractive index, an Abbe's number) of the first through fourth lenses **110** through **140**, the optical filter **150**, etc., which constitute the optical lens system **100**. Referring to Table 1, in the present embodiment, it is to be readily understood that the first surface **111** (S1) of the first lens **110** performs the function of an iris.

Referring to Table 1, the thickness of the first lens **110** is 0.621 mm, and the distance from the second surface **112** (S2) of the first lens **110** to the third surface **121** (S3) of the second lens **120** is 0.113 mm. Also, the first lens **110** has a refractive index of 1.530 and an Abbe's number of 55.8. In Table 1, S1 denotes the first surface **111** of the first lens **110**, and the symbols l, n and υ excluding r (radius of curvature) designate the optical characteristics of the first lens **110**. Also, S3, S5 and S7 represent l, n and υ characteristics of the second through fourth lenses **120**, **130** and **140**. The symbol r designates the radius of curvature of a corresponding surface.

In the present embodiment, the optical filter **150** can be arranged between the image sensor **160** and the eighth surface **142** (S**8**) of the fourth lens **140**. The optical filter **150** has a ninth surface **151** (S**9**) and a tenth surface **152** (S**10**).

Mathematical Expression (8) below is adopted in the design of aspherical surfaces in the present and the following embodiments.

$$x = \frac{c^2y^2}{1+\sqrt{1-(K+1)c^2y^2}} + Ay^4 + By^6 + Cy^8 + Dy^{10} + Ey^{12} \quad (8)$$

In Mathematical Expression (8), x is the size of a lens measured from an apex in the direction of an optical axis, and y is the size of the lens measured in the direction perpendicular to the optical axis. Also, c is a reciprocal of the radius of curvature at the apex of the lens, and K is a conic constant.

A, B, C and D represent respective aspherical coefficients.

The following Table 2 provides aspherical surface design data of the respective first through fourth lenses **110** through **140**.

TABLE 2

	K	A	B	C	D
S1	−1.687059	0.132625E−01	0.345878E−02	0.141762E+00	0.134290E+00
S2		0.105947E+00	−0.365636E+00	0.332240E+00	
S3		0.118393E+00	−0.417727E+00	0.438847E+00	
S4	2.095797	0.297624E−01	−0.232413E+00	0.146462E+00	
S5	−0.344280	0.259796E−01	0.158739E+00	0.125593E+00	0.214694E−01
S6	−3.111465	−0.133051E+00	0.139008E+00	0.459230E−01	−0.381836E−01
S7	398.381580	−0.530388E−01	0.423236E−01	−0.986005E−02	0.884700E−03
S8	−9.571073	−0.985531E−01	0.355642E−01	−0.952298E−02	0.109635E−02

FIG. **2** is graphs illustrating the aberration characteristics of the optical lens system **100** shown in FIG. **1**. In FIG. **2**, light having the wavelength of 435~656.2725 nm was employed to measure the aberrations of FIG. **2**. FIG. **2**(*a*) is a graph which illustrates longitudinal spherical aberration measured depending upon the wavelength of light.

FIG. **2**(*b*) is a graph which is obtained by measuring astigmatic aberration in a direction perpendicular to the optical axis of the light having the wavelength of 546.0740 nm. Assuming that the direction in which light travels is the optical axis (z), the astigmatic aberrations on x and y axes are illustrated. FIG. **2**(*c*) is a graph which illustrates distortion, that is, percentage (%) of distortion of the light having the wavelength of 546.0740 nm depending upon the height of an image. It is to be appreciated that no change occurs up to 1.69 mm, and distortion less than 1.0% occurs at a height which is greater than that.

SECOND EMBODIMENT

FIG. **3** is a view illustrating an optical lens system according to a second embodiment of the present invention. As shown, the optical lens system **200** according to this second embodiment of the present invention includes first through fourth lenses **210**, **220**, **230** and **240**, an image sensor **260**, and an optical filter **250**. The first lens **210** has a first surface **211** (S**1**) and a second surface **212** (S**2**), the second lens **220** has a third surface **221** (S**3**) and a fourth surface **222** (S**4**), the third

lens **230** has a fifth surface **231** (S**5**) and a sixth surface **232** (S**6**), and the fourth lens **240** has a seventh surface **241** (S**7**) and an eighth surface **242** (S**8**).

The following Table 3 provides the optical characteristics, intervals and thicknesses of the respective lenses **210** through **240** and the optical filter **250**, which constitute the optical lens system **200** of the present embodiment. The optical lens system **200** of the present embodiment is based on the same conditions as the first embodiment (that is, the overall effective focal distance f is 3.5 mm, f number (f/#) is 2.8, and an angle of view (2ω) is 66.5°).

TABLE 3

	surface condition	R	l	N	Y	remarks
S1	aspherical	1.765	0.520	1.530	55.8	iris
S2	aspherical	−5.043	0.115			
S3	aspherical	5.399	0.400	1.639	23.4	
S4	aspherical	1.609	0.577			
S5	aspherical	−2.258	0.657	1.530	55.8	
S6	aspherical	−0.788	0.175			

TABLE 3-continued

	surface condition	R	l	N	Y	remarks
S7	aspherical	−39.352	0.440	1.530	55.8	
S8	aspherical	1.206	0.416			
S9		∞	0.3	1.517	64.2	
S10		∞	0.7			

Table 3 illustrates the basic optical characteristics of the optical lens system **200** according to the present embodiment. That is to say, Table 3 illustrates the optical characteristics (including a radius of curvature, an interval, a refractive index, and an Abbe's number) of the first through fourth lenses **210** through **240** and the optical filter **250**, which constitute the optical lens system **200**. Referring to Table 3, in the present embodiment, it is to be understood that the first surface **211** (S**1**) of the first lens **210** performs the function of an iris.

Referring to Table 3, the thickness of the first lens **210** is 0.520 mm, and the distance from the second surface **212** (S**2**) of the first lens **210** to the third surface **221** (S**3**) of the second lens **220** is 0.115 mm. Also, the first lens **210** has a refractive index of 1.530 and an Abbe's number of 55.8. In Table 1, S**1** denotes the first surface **211** of the first lens **210**, and the symbols l, n and υ excluding r (radius of curvature) designate the optical characteristics of the first lens **210**. Also, S**3**, S**5** and S**7** represent l, n and υ characteristics of the second through fourth lenses **220**, **230** and **240**.

In the present embodiment, the optical filter **250** can be arranged between the image sensor **260** and the eighth surface **242** (S**8**) of the fourth lens **240**. The optical filter **250** has a ninth surface **251** (S**9**) and a tenth surface **252** (S**10**). Also, the aspherical surfaces of the present embodiment satisfy the above-described Mathematical Expression (8). The following Table 4 provides aspherical surface design data of the respective first through fourth lenses **210** through **240**.

TABLE 4

	K	A	B	C	D
S1	−1.531430	0.161074E−01	−0.359165E−02	0.108425E+00	0.105203E+00
S2		0.128970E+00	−0.363977E+00	0.350781E+00	
S3		0.132750E+00	−0.393994E+00	0.431878E+00	
S4	1.764084	0.475038E−02	−0.219254E+00	0.129896E+00	
S5	0.702098	−0.198331E−01	0.194910E+00	−0.113223E+00	0.926236E−02
S6	−3.232841	−0.179884E+00	0.153732E+00	0.516941E−01	−0.404593E−01
S7	400.691010	−0.582183E−01	0.422571E−01	−0.965916E−02	0.905382E−03
S8	−10.172361	−0.103548E+00	0.358552E−01	−0.948388E−02	0.115106E−02

FIG. **4** is graphs illustrating the aberration characteristics of the optical lens system **200** shown in FIG. **3**. In FIG. **4**, light having the wavelength of 435~656.2725 nm was employed to measure the aberrations of FIG. **4**. FIG. **4**(*a*) is a graph which illustrates longitudinal spherical aberration measured depending upon the wavelength of light.

FIG. **4**(*b*) is a graph which is obtained by measuring astigmatic aberration in a direction perpendicular to the optical axis of the light having the wavelength of 546.0740 nm. Assuming that the direction in which light travels is the optical axis (z), the astigmatic aberrations on x and y axes are illustrated. As shown in FIG. **4**(*b*), the astigmatic aberrations of the optical lens system according to the present embodiment on the x and y axes are constant within the range less than ±0.1.

FIG. **4**(*c*) is a graph which illustrates distortion, that is, percentage (%) of distortion of the light having the wavelength of 546.0740 nm depending upon the height of an image. It is to be appreciated that no change occurs up to 1.69 mm, and distortion less than 1.0% occurs at a height which is greater than that.

THIRD EMBODIMENT

FIG. **5** is a view illustrating an optical lens system according to a third embodiment of the present invention. As shown, the optical lens system **300** according to this third embodiment of the present invention includes first through fourth lenses **310**, **320**, **330** and **340**, an image sensor **360**, and an optical filter **350**.

The following Table 5 provides the optical characteristics, intervals and thicknesses of the respective lenses **310** through **340** and the optical filter **350**, which constitute the optical lens system **300** of the present embodiment. The optical lens system **300** of the present embodiment is based on the same conditions as the first embodiment (that is, the overall effective focal distance f is 3.5 mm, f number (f/#) is 2.8, and an angle of view (2ω) is 66.5°).

TABLE 5

	surface condition	R	l	n	υ	remarks
S1	aspherical	1.71037	0.545075	1.530	55.8	Iris
S2	aspherical	−5.07311	0.09			
S3	aspherical	5.130765	0.4	1.639	23.4	
S4	aspherical	1.550323	0.602462			
S5	aspherical	−2.47442	0.681484	1.530	55.8	
S6	aspherical	−0.81139	0.156862			
S7	aspherical	−44.925	0.44	1.530	55.8	
S8	aspherical	1.213822	0.384118			
S9		∞	0.3	1.517	64.2	
S10		∞	0.7			

Table 5 illustrates the basic optical characteristics of the optical lens system **300** according to the present embodiment. That is to say, Table 5 illustrates the optical characteristics (including a radius of curvature, an interval, a refractive index, and an Abbe's number) of the first through fourth lenses **310** through **340** and the optical filter **350**, which constitute the optical lens system **300**. Referring to Table 5, in the present embodiment, it is to be understood that the first surface **311** (S**1**) of the first lens **310** performs the function of an iris.

Referring to Table 5, the thickness of the first lens **310** is 0.545075 mm, and the distance from the second surface **312** (S**2**) of the first lens **310** to the third surface **321** (S**3**) of the second lens **320** is 0.09 mm. Also, the first lens **310** has a refractive index of 1.530 and an Abbe's number of 55.8. In Table 1, S**1** denotes the first surface **311** of the first lens **310**, and the symbols l, n and υ excluding r (radius of curvature) designate the optical characteristics of the first lens **310**. Also, S3, S**5** and S**7** represent l, n and υ characteristics of the second through fourth lenses **320**, **330** and **340**.

In the present embodiment, the optical filter **350** can be arranged between the image sensor **360** and the eighth surface **342** (S**8**) of the fourth lens **340**. The optical filter **350** has a ninth surface **351** (S9) and a tenth surface **352** (S**10**). Also, the aspherical surfaces of the present embodiment satisfy the above-described Mathematical Expression (8). The following Table 6 provides aspherical surface design data of the respective first through fourth lenses **310** through **340**.

TABLE 6

	K	A	B	C	D
S1	−1.463708	0.173257E−01	−0.377989E−02	0.103567E+00	0.102032E+00
S2	0.062096	0.124875E+00	−0.349809E+00	0.330231E+00	0.258785E−02
S3	3.864732	0.112253E+00	−0.372710E+00	0.487427E+00	−0.936468E−01
S4	1.416216	−0.218066E−01	−0.157651E+00	0.111091E+00	0.588574E−02
S5	1.681684	−0.414864E−01	0.140873E+00	−0.646771E−01	−0.159357E−01
S6	−3.327528	−0.168482E+00	0.122373E+00	0.359170E−01	−0.287494E−01
S7	522.934092	−0.573610E−01	0.418083E−01	−0.954537E−02	0.913216E−03
S8	−9.968378	−0.990169E−01	0.344211E−01	−0.934957E−02	0.120638E−02

FIG. **6** is graphs illustrating the aberration characteristics of the optical lens system **300** shown in FIG. **5**. In FIG. **6**, light having the wavelength of 435~656.2725 nm was employed to measure the aberrations of FIG. **6**. FIG. **6**(*a*) is a graph which illustrates longitudinal spherical aberration measured depending upon the wavelength of light.

FIG. **6**(*b*) is a graph which is obtained by measuring astigmatic aberration in a direction perpendicular to the optical axis of the light having the wavelength of 546.0740 nm. Assuming that the direction in which light travels is the optical axis (z), the astigmatic aberrations on x and y axes are illustrated. As shown in FIG. **6**(*b*), the astigmatic aberrations of the optical lens system according to the present embodiment on the x and y axes are constant within the range less than ±0.1.

FIG. **6**(*c*) is a graph which illustrates distortion, that is, percentage (%) of distortion of the light having the wavelength of 546.0740 nm depending upon the height of an image. It is to be appreciated that the distortion occurs within the range less than 1.0%.

The optical lens system according to the present invention provides advantages in that, since it includes four aspherical lenses, a high resolution and a light weight can be achieved while the optical lens system can be miniaturized.

While the invention has been shown and described with reference to certain exemplary embodiments thereof, it will be understood by those skilled in the art that various changes in form and details may be made therein without departing from the spirit and scope of the invention as defined by the appended claims.

What is claimed is:

1. An optical lens system having an effective focal distance f comprising:

a first lens having positive lens power and an effective focal distance f_1;

a second lens having negative lens power and an effective focal distance f_2;

a third lens having positive lens power and an effective focal distance f_3; and

a fourth lens having negative lens power and an effective focal distance f_4,

wherein the first through fourth lenses are sequentially arranged from a subject, and satisfy at least the following conditions:

$$1 < \frac{f_1}{f_3} < 1.5;$$

$$1.3 < \frac{f_4}{f_2} < 2.0.$$

2. The optical lens system according to claim **1**, wherein at least one of the first through fourth lenses has an aspherical surface.

3. The optical lens system according to claim **1**, wherein at least one of die first through fourth lenses is made of plastic.

4. The optical lens system according to claim **1**, wherein the optical lens system satisfies the following mathematical expression:

$$0.4 < \frac{f_3}{f} < 0.7.$$

5. The optical lens system according to claim **4**, wherein the optical lens system satisfies the following mathematical expression:

$$20 < \upsilon d_1 - \upsilon d_2$$

where υd, is an Abbe's number of the first lens, and υd_2 is an Abbe's number of the second lens.

6. The optical lens system according to claim **1**, wherein the optical lens system satisfies the following mathematical expression:

$$\frac{TTL}{f} < 1.3$$

where TTL is a distance from a fIrst surface of the first lens facing the subject to an image surface, and f is an effective focal distance of the entire optical lens system.

7. The optical lens system according to claim **1**, wherein the optical lens system satisfies the following mathematical expression:

$$-1 < \frac{f_4}{f} < -0.4.$$

8. The optical lens system according to claim **1**, further comprising an iris arranged between to first lens and the subject.

9. The optical lens system according to claim **1**, wherein a first surface of the first lens comprises an iris.

10. The optical lens system according to claim **1**, further comprising an iris arranged between the first lens and thc second lens.

11. The optical lens system according to claim **1**, wherein a second surface of the first lens comprises an iris.

12. The optical lens system according to claim **1**, wherein the optical lens system satisfies the following mathematical expression:

$$20 < \upsilon d_1 - \upsilon d_2$$

where υd_1 is an Abbe's number of the first lens, and υd_2 is an Abbe's number of the second lens.

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